"Glass Rock"

Advanced Orebody Knowledge Programme

COAL DOL JUNE 2025

Michelle Pienaar

Accelerating Mining RDI

Integrating Research Excellence with Mining Innovation

MANDELA MINING PRECINCT

MANDELA MINING PRECINCT
MINDS FOR MINES

The Mandela Mining Precinct facilitates and coordinates the implementation of the SAMERDI strategy and associated strategic initiatives in the minerals sector

SAMERDI MISSION

"To maximise the sustainable returns of South Africa's mineral wealth through collaborative research, development, innovation & implementation of mining technologies in a socially, environmentally and financially sustainable manner that is rooted in the local community and national economy."

- **Successful Application of Technologies Centred Around People** (SATCAP) - The aim of the SATCAP Programme is to understand the challenges, effects and impacts of mining modernisation on people in the minerals sector. **Dr Sherin Ramparsad**
- **Longevity of Current Mines** (LoCM) – Designed to increase the efficiency of ore reserve extraction, improvement in Occupational Health and Safety and the reduction in costs of current conventional mining operations. **Martin Pretorius**
- **Mechanised Mining Systems** (MMS) – providing sustainable mechanised drill, blast and mechanical rock breaking solutions in advancement to facilitate achieving zero harm, whilst maintaining and defending desired production rates at minimised costs, within the Au, and PGM mining industries. **Martin Pretorius**
- **Real Time Information Management Systems** (RTIMS) - Aims to develop and implement smart connected systems for mining from sensor to dashboard. **Marius Auret**

GLASS ROCK: REEF & HAZARD MAPPING AHEAD OF THE FACE

- **Advanced Orebody Knowledge** (AOK) – Aims to create the ultimate ''Glass Rock'' environment which includes improving geological confidence ahead of the face, reduction or identification of risks associated with geology & ultimately to have timeous information.

Smart Drill	*Further development of the ''Smart Drill'' which will include machine learning and optimisation of diamond drilling practices.*
Technologies ahead of the face	*A tool which can be used for mine design and planning. Further investigation and Development of plug-and-play software for geological data and analysis.*
Technologies on the face	*Technologies on the face which will include a sensor mounted console prototype development that can identify risk associated with Falls of ground.*
Research Dissemination	*Research dissemination which includes participating/presenting at the most applicable technical conferences which will include having work done peer reviewed and published.*

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AOK TECHNOLOGIES

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Technologies ahead of the face

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Geophysical and Remote Sensing

- **Tunnel Seismic Profiling (TSP) -** A geophysical method used in mining to detect geological structures ahead of the tunnel face, improving safety and mine planning
- **Ground Penetrating Radar (GPR) -** A geophysical technique used in mining to detect geological discontinuities, fractures, and lithological variations within the hanging wall and footwall.
- **Electric resistance tomography (ERT)**– Locates conductive weak zones and discontinuities
- **LIDAR** – Tracks subsidence and surface deformations.
- **EPEGS -** RTLS enhancing underground tracking with UWB technology, improving deployment, scalability, monitoring, and safety in mining.

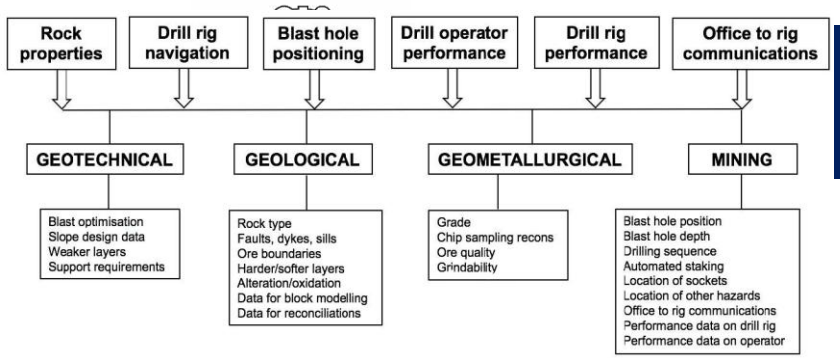
Diamond Drilling and Sampling

- **The Smart Drill -** Improves underground drilling efficiency by enhancing accuracy and providing real-time geological data.
- **Laser-Induced Breakdown Spectroscopy (LIBS) is -** rapid chemical analysis technology used in mining to assess platinum and gold grades, helping improve ore characterization and resource evaluation.
- **X-ray Diffraction (XRD) and X-ray Fluorescence (XRF) -** analytical techniques used in mining to determine mineral composition and elemental content, aiding in ore characterization, grade control, and processing efficiency.

Data/AI/ML

- **Statistical analysis and machine learning -** were used to predict potholes, ore grades, and geological structures ahead of the mining face.
- **AI in Smart Drilling -** Development of an intelligent diamond drill rig with AI-driven real-time data processing.
- **AI -** Rock Hazard Identification (ITAD & Stratafy Seeker)
- **AI in Geophysical Data Integration**: - AI-assisted data fusion integrates multiple technologies like GPR, LiDAR, Seismic Profiling, and ERT to build high-resolution 3D model.

Further development of the "SMART DRILL" *which will include machine learning and optimisation of diamond drilling practices*



06 **Year 6**

2025/26 to look at least seven different **models/methodologies** which will be trained on the 2023/24 data to classify core. The results of these will be evaluated and compared with regards to different aspects such as accuracy, number of sensors required and computational cost of training and processing. From these, the optimal AI methodology/model will be identified.

2023/25: **Instrumentation** of Adder rig. Diamond drilling operations to commence with instrumented rig – **data collection** and recording will then take place

https://youtu.be/Kjbv8yDwf8c

SENSORS

- DATALOGGER
- STEPDOWN TRANSFORMER
- BATTERY
- MICROPHONE
- HYDRAULIC SENSOR
- TILT SENSOR
- LASER DISPLACEMENT SENSOR
- STRAIN GAUGE
- TACHOMETER

Parameters

- Force
- Displacement
- Rotational speed / torsional vibration
- Torque
- Vibration
- Hydraulic actuator force/displacement
- Drill rotational speed

05 **Year 5**

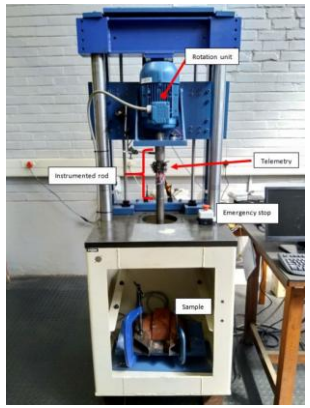
YEAR 4 04

In **2022/23** an industrial original equipment manufacturer **(OEM) partner** was identified as well as a service provider that already developed a solution in Sweden for tunnel boring.

03 **YEAR 3**

During **2021/22** the AOK project team identified **leading practices** within other industries and commodities which could be adapted to improve diamond drilling practices within deep level tabular orebodies.

YEAR 2 02



In the **2020/21, a laboratory test setup** was built to establish the feasibility of this approach. It was demonstrated experimentally that drill operational parameters including torque, weight on bit and rotational speed can be used to successfully classify rock type.

01 **Year 1**

In the **2019/20, possible solutions** were sought to address the low drilling rates typically achieved with underground diamond drilling in the South African mining industry (SAMI). The lack of access to skilled drill operators in the SAMI was identified to negatively affect drill performance in terms of drilling rate, hole accuracy and drill bit wear, is. One solution is the development of a Smart Drill. This concept revolves around the idea that a skilled drill operator makes use of sensory inputs such as vibration, noise and visual feedback during drilling to adjust the operational parameters in real-time (such as rotational speed and rate of penetration), to yield optimal performance of the machine.

SHOWCASE EVENT

OBJECTIVE

Identify tools and technologies that can be used for geological features/modelling (i.e. mine design and planning) and showcase them through an open- day event.

PURPOSE

Present readily available tools and technologies in geoscience from South African technology producers to the mining industry for potential commercialisation opportunities.

OUTPUT

A **showcase event** to bring together technology producers and the South African mining industry. Includes:

- Market research on technology providers relating to geoscience.
- Hosting a showcase event to present the various technologies, as well as other MMP programmes

OUTCOMES

The **following outcomes** are intended for the showcase event:

a) Industry recognition for technology, which can ultimately assist with mine design and planning.
b) Increased information exchange between stakeholders to demonstrate technology enablers for potential industry use.
c) Inform stakeholders of the outputs from adjacent SAMERDI programme work streams.

The event had 476 registered attendees. From the total number, **343 attended.** The total attendees comprised 207 registered (60%) and 136 unregistered attendees (40%).

Industry	Count	Proportion (%)
Academia	119	34.6
OEM	75	21.9
Government	62	18.1
Mining House	54	15.7
Professional Services	28	8.2
Union	4	1.2
Media House	1	0.3
Total:	**343**	**100**

SHOWCASE EVENT

Desktop research on the following key geoscientific technology categories has been the focus area. **The collective research effort across the team resulted in over 269 technologies being identified**. These were then critically evaluated according to relevance for the AOK. In total, **171 technologies were then confirmed.**

Mapping & Sampling

Spatial data is collected, processed, and visualised to represent the Earth's subsurface geological formations, mineral deposits, and structural features. Sampling technologies collect and analyse geological materials to determine mineral deposits' composition, quality, and economic potential.

- Mineralogy
- Geophysics
- Rock mass characterisation
- Geological mapping
- Structural geology
- Geological sampling
- Drilling and sampling

Technology Count = 64

Monitoring & Planning

Monitoring technologies track geological, geoscientific, and environmental data, ensuring safety, efficiency, and environmental compliance in mining operations. Planning technologies use software to design, optimise, and manage mining operations, providing detailed insights for decision- making.

- Geotechnical
- Mine design and planning

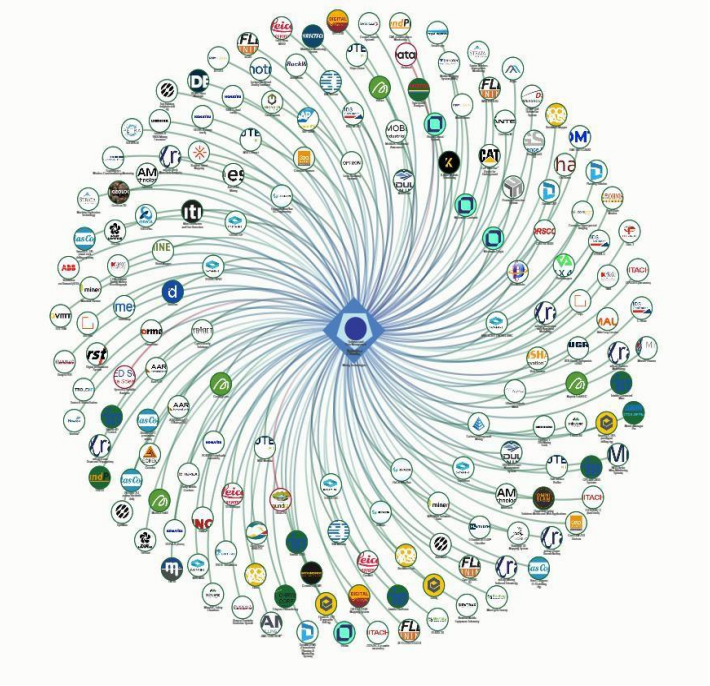
Technology Count = 77

Software & Data Management

Specialised software applications designed to analyse, model, visualise, and interpret geological data for various mining stages. Data management technologies involve collecting, storing, organising, and retrieving geological and mining data.

- Mineral economics
- Statistics
- Software
- Resource estimation
- SLAM, LIDAR, Drones
- Data management
- 3D modelling

Technology Count = 42



Click For Interactive Link

STRATAFY SEEKER

For *Assisted RISK IDENTIFICATION*

BY: ***STRATAFY SOLUTIONS***

science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

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MINERALS COUNCIL
SOUTH AFRICA

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STRATAFY SEEKER

Testing the User Friendliness

AIM

- A system that allows real-time monitoring
- Pro-active warning of unsafe environments and possible hazards at the face
- Integrated scanning hardware and software for reef identification
- Support quantification
- Identify geological structures on the face
- Optimise lighting and camera layout
- Need to be user friendly
- Need to be able to scan the side-wall and hanging-wall
- Scanning difficult areas
- Easily adoptable by any individual

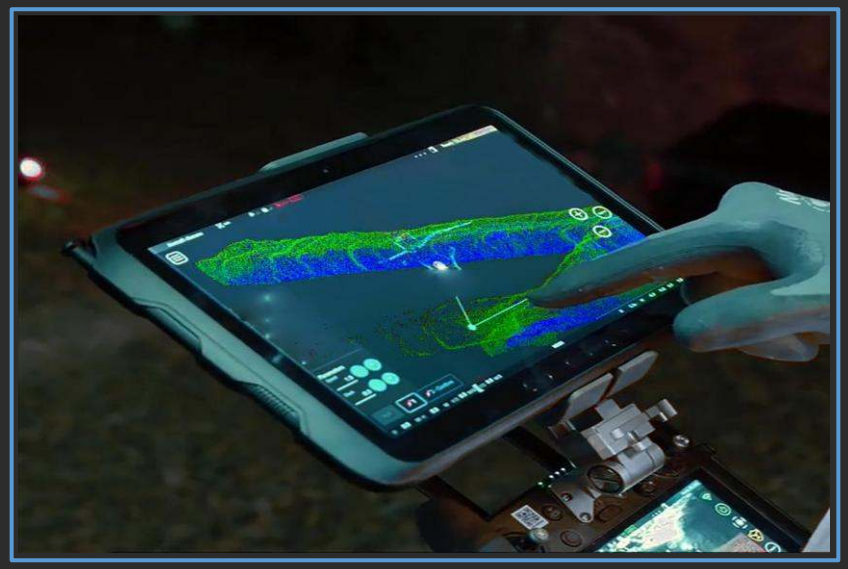
STRATAFY

STRATAFY SEEKER

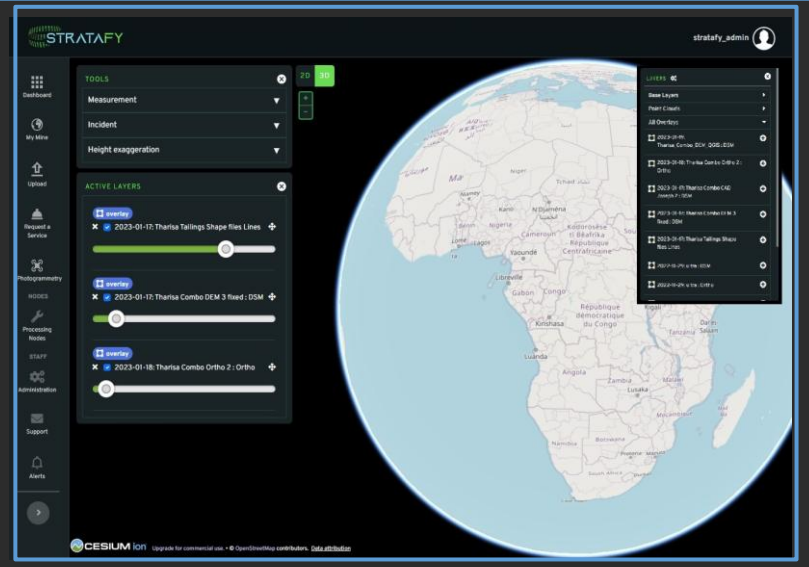
Completed (With Continuous Development)

Part 1:
The SEEKER Scanning Head

Initiated on both Part 1 & Part 2



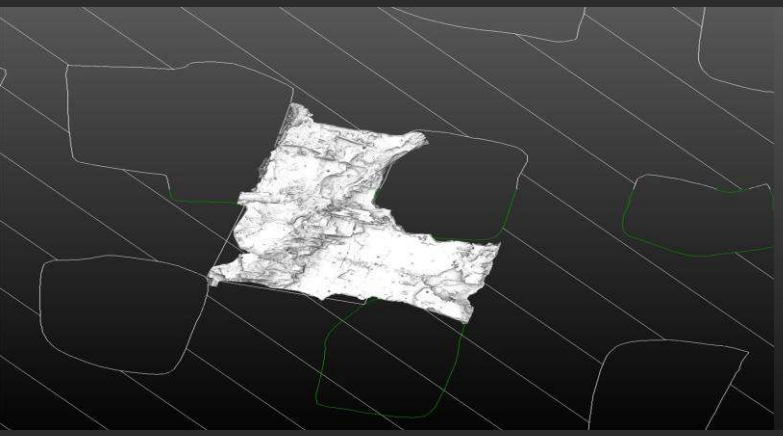
Part 2:
Processing Pod with Display Screen (Handheld Device)

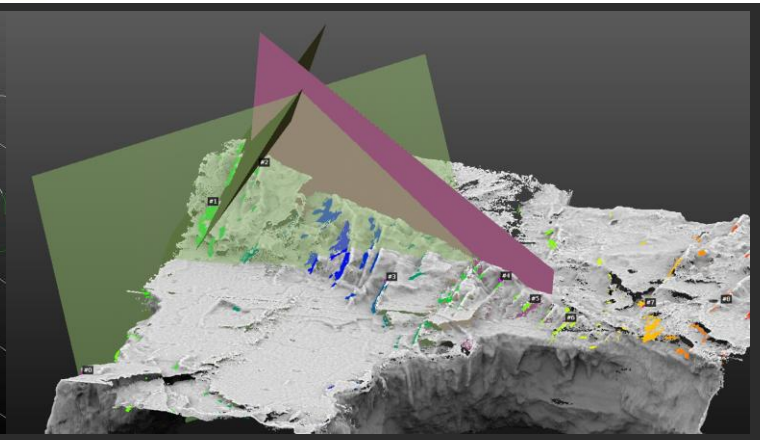


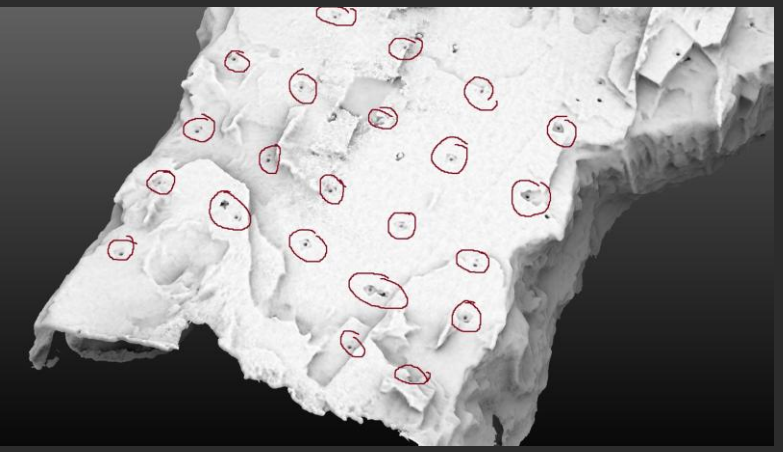
Part 3:
Cloud Computing Platform (Stratafy)

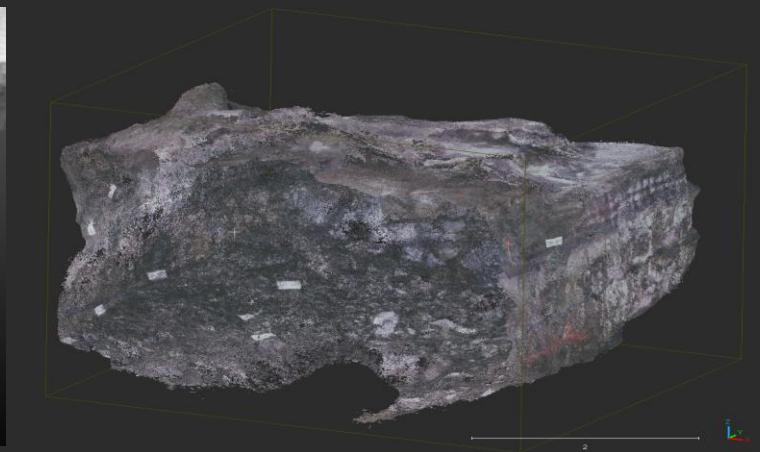
STRATAFY

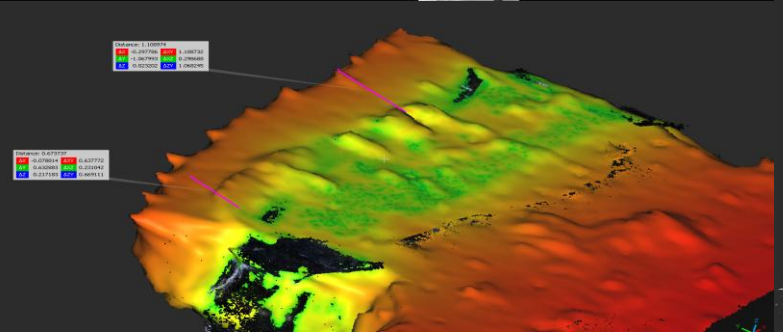
STRATAFY SEEKER

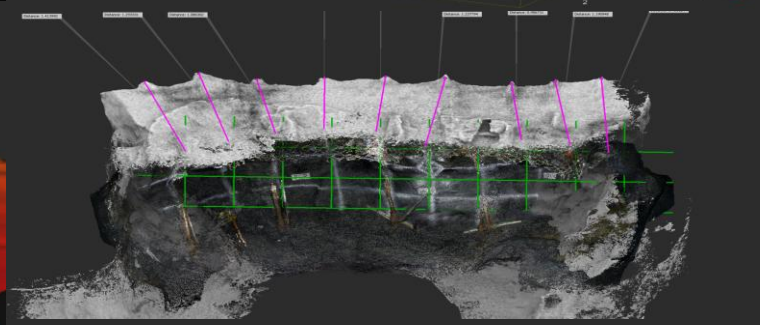












USE-CASES

- Georeferencing
- Structures/Joints/Fault planes
- Measure support units
- Pre-post blasting analysis
- Fragmentation studies
- Volumetric measurements
- Drilling patterns and orientation
- Accident investigations??

STRATAFY

Next steps – Near Real-Time Feedback to User


RX STANDARD
Microphone.mp4
Repair Assistant
ACOUSTIC
ROCK HAZARD
MANAGEMENT
Loose
Solid
All
Module Chain
Repair
Breath Control
De-bleed
Waveform Statistics
L
R
True peak level -0,60 dB -0,60
Sample peak level -0,67 dB -0,67
Max. RMS level -5,44 dB -5,44
Min. RMS level -Inf. dB -Inf.
Total RMS level -21,10 dB -21,10
Possibly clipped samples 0 0
DC offset 0,000% 0,000
Max. momentary loudness -8,5 LUFS
Max. short-term loudness -10,9 LUFS
Integrated BS.1770-2/3/4 loudness -17,5 LUFS
Loudness range (LRA) 22,0 LU
Voice De-noise
Utility
Dither
EQ
Fade
Gain
Loudness Control
Mixing
Normalize
Phase
Plug-in
Resample
Instant process
Attenuate
h:m:s.ms
00:00:26.157
Start End Length Low High Range
Sel 00:00:26.157
View 00:00:22.689 00:00:27.721 00:00:05.032 0 24000 24000
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ACOUSTIC ROCK HAZARD MANAGEMENT

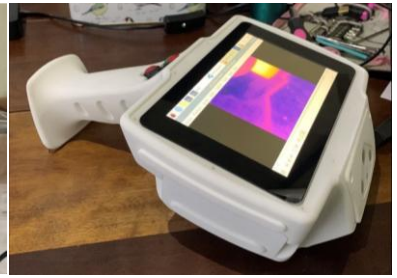
ESD V1.0 – ELECTRONIC SOUNDING DEVICE (ESD)

- Mounted on hardhat
- Lightweight and portable
- Audible beeps communicate with miner
- Not very user-friendly
- Entered license agreement which did not work out.
- Still maintain IP

ITAD V2.0 – INTEGRATED THERMAL ACOUSTIC DEVICE

- Increased haptic feedback and user-friendliness
- Portable handheld device
- Not trialed or tested in a mine
- Hardware specific design
- Limitations on computation

ITAD V3.0 – INTEGRATED THERMAL ACOUSTIC DEVICE



- Larger screen
- More computational capacity
- Increasing field-of-vision for thermal image.
- More interoperable
- Tested underground – focused on PGM environment
- Thermal studies unsuccessful Device unreliable in the underground environment
- General good results

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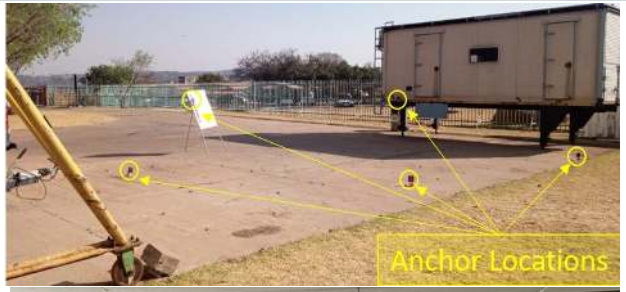
ACOUSTIC ROCK HAZARD MANAGEMENT

Underground Data Collection & Acoustic Refinement

- **Timing & Noise Control:**
  - Data collection was conducted **early in shifts** to minimise production noise.
  - Crews briefly paused drilling to facilitate **acoustic recording**.
  - Background noises were recorded for **post-processing adjustments**.
- **Optimising Acoustic Data:**
  - Gain settings were adjusted to enhance the **signal-to-noise ratio**.
- **Mine & Lithology Selection:**
  - Focused on **gold mines** with suitable lithology (**lava, quartzite, conglomerate**).
  - Mines were briefed in advance to prioritise **on-reef, low-noise environments**.
- **Enhancements for Accuracy:**
  - **iPhone optimised** to focus solely on relevant **rock soundings**.
  - **Noise elimination & sensitivity adjustments**

E-PEGS



OBJECTIVE 1	OBJECTIVE 2	OBJECTIVE 3
Auto-locating Anchors	Data Export	Server / Tablet

Anchor	
Battery life	8 hours
Range	40 m
E-peg	
Battery life	8 hours
Range	40 m
Server	
Battery life	10 hours
Range	70 m
Tablet	
Battery life	20 hours
Range	70 m

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E-pegs

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REUTECH
MINING

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